

REMARKS

This amendment, submitted in response to the Office Action dated May 10, 2002, is believed to be fully responsive to each point of rejection raised therein. Accordingly, favorable reconsideration on the merits is respectfully requested.

Turning to the merits of the Office Action, claims 1-8 remain pending in the application. Claims 2, 4 and 6 have been rejected under 35 U.S.C. Section 112, second paragraph, as being indefinite. Claims 1-8 have been rejected under 35 U.S.C. Section 102(b) as being anticipated by Kondo (U.S.P. 5,572,539). Claims 4 and 6 are amended without narrowing the scope of the claims.

To expedite prosecution of this case, Applicant cancels claim 1 and rewrites claims 2 and 8 in independent form. The dependencies of claims 2, 5 and 7 are also rewritten. Applicant further respectfully submits the following arguments in traversal of the Section 112 and prior art rejections.

With regard to the rejection of claim 2, the Examiner maintains that claim 2 is indefinite for failing to include an upper limit. Even assuming, *arguendo*, that claim 2 may include thicknesses of infinite value, one skilled in the art would understand that realistic optical structures would not include such infinite values. Claim 2 clearly sets forth a minimum value for the sum of thicknesses of two layers and is clearly understood by the skilled artisan. No upper limit is required to meet the requirements of Section 112 in this instance. Applicant requests that the Section 112 rejection of claim 2 be withdrawn.

Turning to the art rejections, Applicant's invention relates to a semiconductor laser that is operable in a fundamental transverse mode in a stable manner even at a high output power. Conventionally, one factor that limits the output power of the fundamental transverse mode is the equivalent refractive index difference in the direction parallel to the active layer. In a laser having a stripe width W , the stability of the fundamental mode becomes limited by a difference in the equivalent refractive index in the area in the active layer under the stripe layer and another region. Fig. 5 shows the tolerance for differences in equivalent refractive index as a function of stripe width W . The area under the curve represents a stable oscillation of the transverse mode. Outside this region, the laser beam becomes shifted in the horizontal direction resulting in unstable oscillations.

Applicant's invention overcomes the problems of instability of the fundamental mode. The present invention includes a quantum well layer disposed between optical waveguide layers, and the quantum well layer is not located at the center of an SCH structure. According to this arrangement of the SCH structure, current injected into the semiconductor laser device does not spread widely, and the semiconductor laser can maintain a stable oscillation in a fundamental transverse mode even under a high output power condition. In addition, the fundamental transverse oscillations are dependent to some degree on a stripe width of an index guided structure. As an additional feature, the sum of the thicknesses of the waveguide layers is .5 micrometers or greater.

Turning to the cited art, Kondo relates to a II-VI semiconductor laser having waveguide layers disposed about an active layer, where the light guide layers have different composition and/or thicknesses. In this manner, Kondo apparently seeks to provide a variable equivalent

index of refraction. Col. 9, lines 38-39. Kondo discloses generally that minimizing the thickness of light guide layers is preferable. Col. 1, lines 29-33. The embodiments of Kondo teach exemplary thicknesses for the light guide layers of 80 nm and 100 nm.

The Examiner maintains that Kondo teaches or suggests each feature of claims 1-8.

However, claim 2 in its originally filed form described that the sum of the thicknesses of the first and second waveguide layers is at least .5 micrometers. By contrast, the maximum sum of thicknesses of the light guide layers in Kondo is 100 nm + 80 nm, which is less than .5 micrometers. Alternative embodiments in the reference also have thicknesses of no more than 200 nm for each guide layer. Therefore, Kondo does not teach each feature of the claim 2 as originally filed. Applicant further submits that Kondo generally teaches that minimizing the thickness of the light guide layers is typically preferred. Therefore, Kondo not only fails to teach features of claim 2 but also teaches away from the claim. Even though the Examiner has rejected claim 2 as being indefinite, the Examiner is obligated to consider the explicit recitations in setting forth an art rejection. MPEP 2143.03. Therefore, claim 2 is not anticipated by Kondo. Claims 3-7 are patentable based on their dependency. Should the Examiner cite any additional references against claim 2, the rejection must be made on a non-final basis.

With further regard to claim 4, this claim describes that the bottom of the current confinement structure is disposed on the upper surface of the upper waveguide layer. By contrast, in Kondo, there is an intervening cladding layer (16) between the upper guide layer (15) and the current confinement structure (21). Therefore, claim 4 is patentable for this additional reason.

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Claim 8, as originally filed described that an index guided structure had a stripe width of 4 micrometers or smaller. However, no discussion of stripe width is provided in the Kondo reference. Moreover, the Examiner has offered no rationale as to why the stripe width is taught or suggested by Kondo. The features of claim 8 have now been included in independent form to expedite prosecution of this case. Claim 8 is allowable for at least this reason.

Applicant adds new claims 9-16 to describe features of the invention more particularly. Claim 9 describes a current confinement layer physically contacting the optical waveguide layer. By contrast, an intervening cladding layer separates the light guide and current confinement layer of Kondo.

In view of the above, Applicant submits that claims 2-8 and 9-16 are in condition for allowance. Therefore it is respectfully requested that the subject application be passed to issue at the earliest possible time. The Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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APPENDIX
VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE TITLE:

Please delete the present title and replace it with the following new title:

FUNDAMENTAL-TRANSVERSE-MODE INDEX-GUIDED SEMICONDUCTOR
LASER DEVICE HAVING UPPER OPTICAL WAVEGUIDE LAYER [THICKER] THINNER
THAN LOWER OPTICAL WAVEGUIDE LAYER

IN THE SPECIFICATION:

Page 14, first full paragraph, delete and insert the following:

The construction of a semiconductor laser device as the second embodiment of the present invention and a process of producing the construction are explained with reference to Fig. 3, which is a cross-sectional view of the semiconductor laser device as the second embodiment.

IN THE CLAIMS:

Claim 1 is canceled without prejudice or disclaimer.

2 (Amended). A semiconductor laser device [according to claim 1,] having an index-guided structure and oscillating in a fundamental mode, comprising:

a lower cladding layer;

a lower optical waveguide layer formed above said lower cladding layer;

a quantum well layer formed above said lower optical waveguide layer;
an upper optical waveguide layer formed above said quantum well layer; and
a current confinement structure formed above said upper optical waveguide layer;
said upper optical waveguide layer has a first thickness smaller than a second thickness of
said lower optical waveguide layer;
wherein a sum of said first and second thickness is 0.5 micrometers or greater.

3 (Amended). A semiconductor laser device according to claim [1] 2, wherein a bottom of said current confinement structure is at a height smaller than 0.25 micrometers above an upper surface of said quantum well layer.

4 (Amended). A semiconductor laser device according to claim 3, wherein said bottom of said current confinement structure is arranged on [said] an upper surface of said upper optical waveguide layer.

5 (Amended). A semiconductor laser device according to claim [1] 2, wherein said lower optical waveguide layer, said quantum well layer, and said upper optical waveguide layer are made of an aluminum-free semiconductor material.

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6 (Amended). A semiconductor laser device according to claim 5, wherein [at least one of] said lower cladding layer [and said upper cladding layer] is made of a semiconductor material containing aluminum.

7 (Amended). A semiconductor laser device according to claim [1] 2, wherein said index-guided structure is an internal stripe type or a ridge waveguide type.

8 (Amended). A semiconductor laser device [according to claim 2,] having an index-guided structure and oscillating in a fundamental mode, comprising:

a lower cladding layer;

a lower optical waveguide layer formed above said lower cladding layer;

a quantum well layer formed above said lower optical waveguide layer;

an upper optical waveguide layer formed above said quantum well layer; and

a current confinement structure formed above said upper optical waveguide layer;

said upper optical waveguide layer has a first thickness smaller than a second thickness of said lower optical waveguide layer;

wherein said index-guided structure has a stripe width of 4 micrometers or smaller.

Claims 9-16 are added as new claims.